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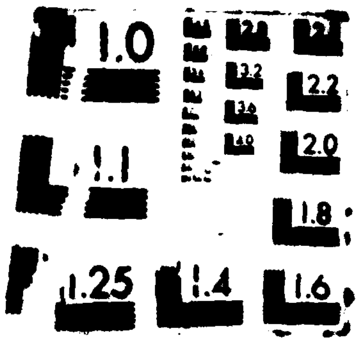
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Report no. : R 87/023
Order no. : 14192
Date : 1987-01-27

PROCEEDINGS OF THE 1984 WORKSHOP HELD AT BUFFALO (NY) USA

J.M. Marquenie, J.W. Simmers (WES)

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CONTENTS

WES

MEMORANDUM FOR RECORD

SUBJECT: Proceedings of the Contaminant Mobility Working Group - 1985

1. The following is a collection of the reports of the Task Groups formed from the participants of the Working Group. The meeting conducted in Buffalo, NY, 13-17 May 1985, served to identify the research pathways followed during 1985.

2. Dr. Joop Marquenie of TNO Laboratories and I feel that the joint WES-TNO Working Group meeting was immeasurably successful and we would like to extend our thanks to all participants and observers for their enthousiastic exchange of ideas.

3. We hope that this summary document will be useful to you and that it will serve as a reference or model for the next Working Group Meeting and the subsequent, more structural proceedings.

John W. Simmers, PhD
Research Biologist

1985 ANIMAL BIOASSAY WORKING GROUP
Attendance Roster

Name	Organization
John Simmers	WES
Dick Lee	WES
Glenn Rhett	WES
Don Crawley	WES
Stratford H. Kay	WES
Robert Lazor	WES
Alena Mudroch	Environment Canada
Gerould Wilhelm	Morton Arboretum, Lisle, Illinois
Wilfrech H.O. Ernst	Free University, Amsterdam
Wim Ma	Res. Institute for Nature Management, Arnhem, NL
Rob H.D. Lambeck	Delta Institute of Hydrobiological Research, Yerseke, NL
Ed Neuhauser	Cornell University
Brian Hunter	British Petroleum International
Chuck Garten	ORNL, Oak Ridge, TN
Hans Gielen	TNO, Delft, The Netherlands
Bill Stickle	Louisiana State Univ., Baton Rouge
Norm Rubinstein	EPA Res. Lab. - Narragansett
Bill Langston	Marine Biological Association, Plymouth, U.K.
Mike Ireland	University of Heidelberg, FRG
Jim Mansky	USACE, NY District
Ludwig Tent	Port of Hamburg
Clive Edwards	Rothamsted Expt. Station, U.K.
Clarence A. Callahan	USEPA, Corvallis, Oregon
Elizabeth Stafford	Rothamsted Expt. Station, U.K.
Nelson Beyer	Patuxent Wildlife Res. Ctr.
Joop Marquenie	TNO, Den Helder, NL
Frank Snitz*	USACE, Detroit District
Anthony Kizlauskas*	USEPA, Great Lakes Nat'l Program
Lex MacCubbin*	Roswell Park Memorial Institute
Todd Higgins	WES
Steve Yaksick*	USACE, Buffalo District
Harish Sikka	Great Lakes Lab, State Univ. College

* Observer

TASK GROUPS

Plant Life

Ernst
Wilhelm
Mudroch
Lazor
Lee

Per Habitat:

- Structural important species
- Abnormalities, lacking species
- Future development
- Needs for research

Soil Invertebrates

Beyer
Stafford
Edwards
Callahan
Hadiman
Kay/Marquenie

Per Habitat:

- Structural important species
- Abnormalities, lacking species
- Future development
- Needs for research

Chemical and Data Analysis

Gielen
Garten
Brandon
Black
Leonard
Adams
Rhett

General impression of the site:

- Important processes
- Which chemicals, how to decrease analysis
- Sample storing for future use
- Impact on water quality

Aquatic/Wetland

Prosi — Aquatic
Ireland
Langston
Rubinstein
Sikka — Wetland
Stickle
Pfeiffer/Roper
Marquenie/Kay

- Importance of aquatic food chains
- Effects
- Basic food sources in the wetland
- Needs for research

Management

Tent
Mansky
Higgins
Simmers

- Potential user
- Needs for monitoring
- Needs for criteria
- Interaction with socio-economics

Food Chains (not aquatic)

Hunter
Ma — Mammals
Andrle
Lambeck
Neuhauser — Birds
Crawley

- What are the species
- Expected percentage of usage of the site
- Expectance of effects on population level
- Needs for research

CONTAMINANT MOBILITY IN FOOD CHAINS - FOOD CHAINS FISH GROUP

INTRODUCTION

The team set the following objectives:

i) to investigate the physical process involved in the creation of the site

ii) assess how this affects the distribution of contaminants

iii) develop understanding of community/food chain development in space and time over the site

iv) examine food chain mobility of contaminants at Times Beach

v) collect information in a way that it can be used to predict the effects of proposed new dredged material disposal sites elsewhere, and that can be used in the evaluation of management options for disposal sites.

To do this, it is realized that our discussions would overlap considerably with those of other groups.

1. Physical factors in description of site

   - point source for dredge pumping
   - differential particle size deposition
   - possible uneven distribution of contaminants linked to particle size deposition: eg. metals and clays; organic and oils/colloidal material.

2. Transect locations (Figure 1)

   - start at dredge pipe input point
   - cross major habitat types
   - incorporate one central point from the previous study
   - located in central area to minimize edge effects (immigration)

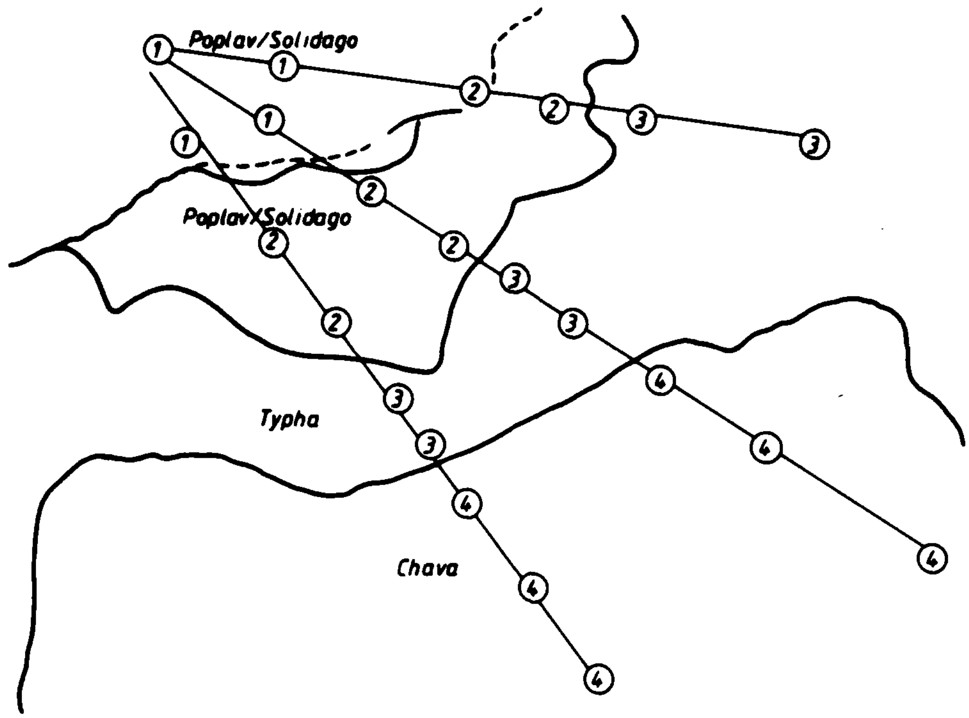

Figure 1

3. Major Habitat Types

i) Non-dredged material/old beach coastline
ii) Popular/Solidago woodland
iii) Typha marsh — dredged material habitats
iv) Aquatic

4. Sample Points

i) Six points per dredged material habitat (4 for non-dredged material)
ii) Points positioned to minimize edge effects between habitat types and to include representative flora

5. Substrate samples (Figure 2)

- sample depth profiles for each zone
- all transect points sampled
- at each point 3 cores, depth divided, bulked and subsampled

6. Substrate analysis (Figure 3)

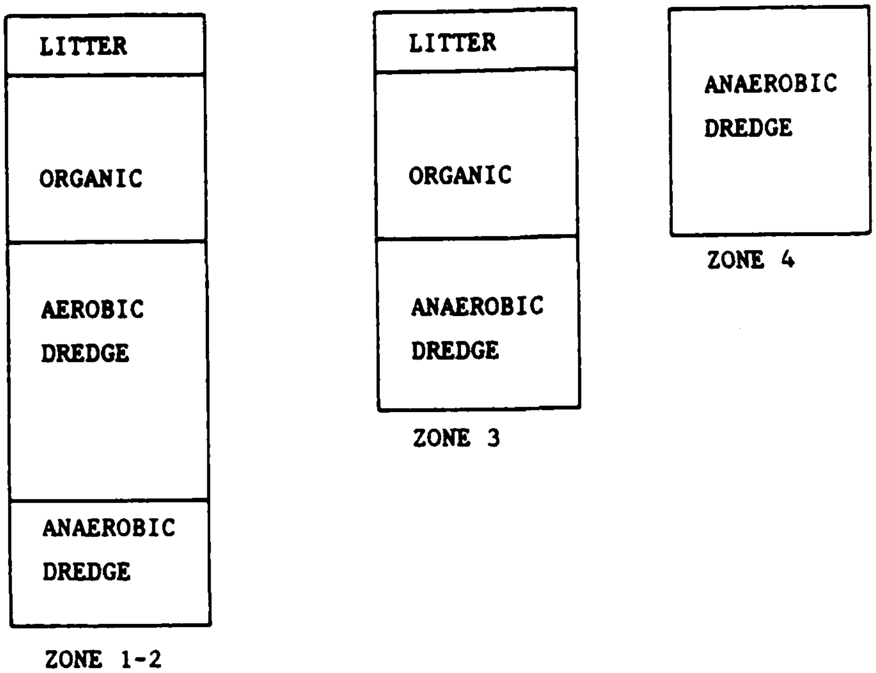

Figure 2

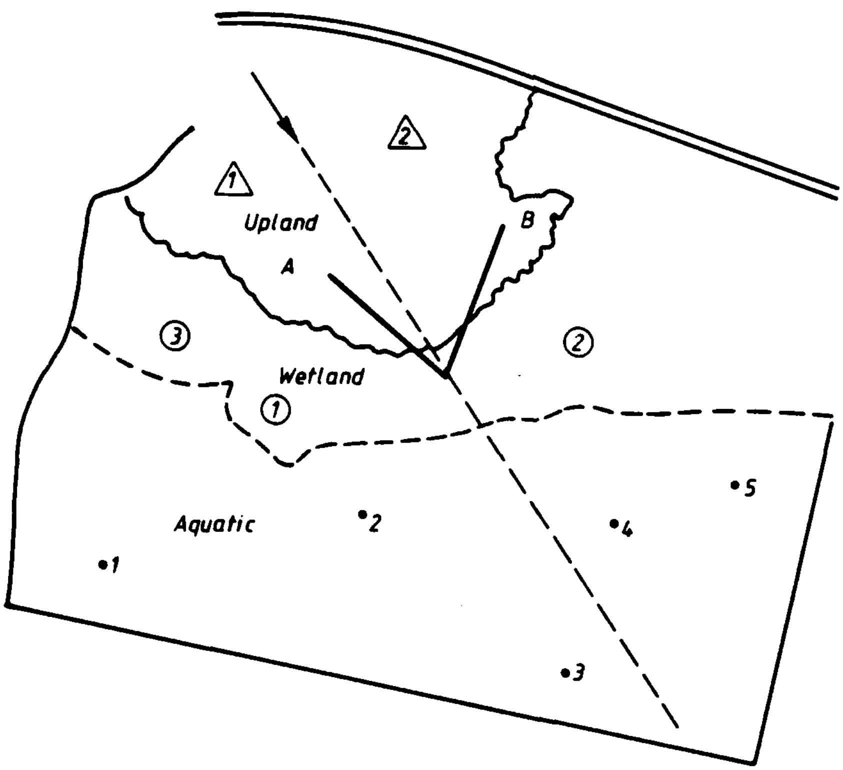

Figure 3 - Aquatic .10 random samples (5 chemical analysis)
- Wetland aside the new transect *
- Upland aside the new transect *
- Old land composite sample

* Humus layer take at same site as sediment

7. Groundwater: boreholes - record depth - unstall groundwater monitoring wells
   - collect chemical data - organics and metals

8. Plants
   - identify major habitat types
   - identify dominant species - 1 Poplar/Salidago
     2 Willow
     3 Typha
     4 Chara
   - restrict collection/analysis to dominants
   - account for seasonal variation
   - sample spring, summer, and fall
   - samples include green leaves (poplar) and whole plants (Solidago/Chara)
   - bulked samples from 10 individuals at each point and subsample
   - one a year in fall collect Poplar twigs: major litter input.

Substrate analysis on each subsample.

1. Physical
   - particle size analysis
   - organic matter content
   - water content

2. Chemical
   - pH and redox
   - plant nutrients - NPK
   - contaminants - metals : plants Cu Ni Zn; animals Cd Pb (Cr, Hg)
     - organics: PCBs, PAHs.etc.

3. Groundwater
   i) depth measurement
   ii) chemical data - metals
     - organics

4. Plants

i) identify major habitat types

ii) identify dominant species

iii) seasonal variation

Zone 1 Poplar and Solidago

2 sampled spring, summer, and fall

3 Tyoha Equisetum

4 Elodea and Chara

9. Earthworms

- only of complexity
- sample zones 1, 2, 3
- sample adults in fall; analyze 10 individuals, unpurged guts

10. Small mammals (Figure)

Figure - sample zones 1, 2, 3

- one collection in fall

Figure - collect older specimens

species -- diets

- tissues KL

specific target organs

11. Birds - identify large us species using site; NO analysis yet (year 1)

- must assess which species most at risk

To do this study - occurrence

- numbers
- feeding areas
- residence time

Year 2 - select species for study

- possible sample yound from nest of common bird - fixed diet, age etc.

Overhead Photo

Oblique from 300 ft

To delineate 8 vegetation types

To delineate upper debris zone

1. Four linear transects radiate from the distal portion of ten year old dredged material disposal pipe, to end at dike (Figure 4).
   (a) To follow elevation gradient, (particle density and contamination level gradients).
   (b) Each transect should be selected to include as many as possible of each of the eight vegetational zones.
   (c) For each transect at each vegetational zone there shall be an approximately 25 m^2 sampling station, within which shall be established 6 permanent subplots, each 1 m^2.

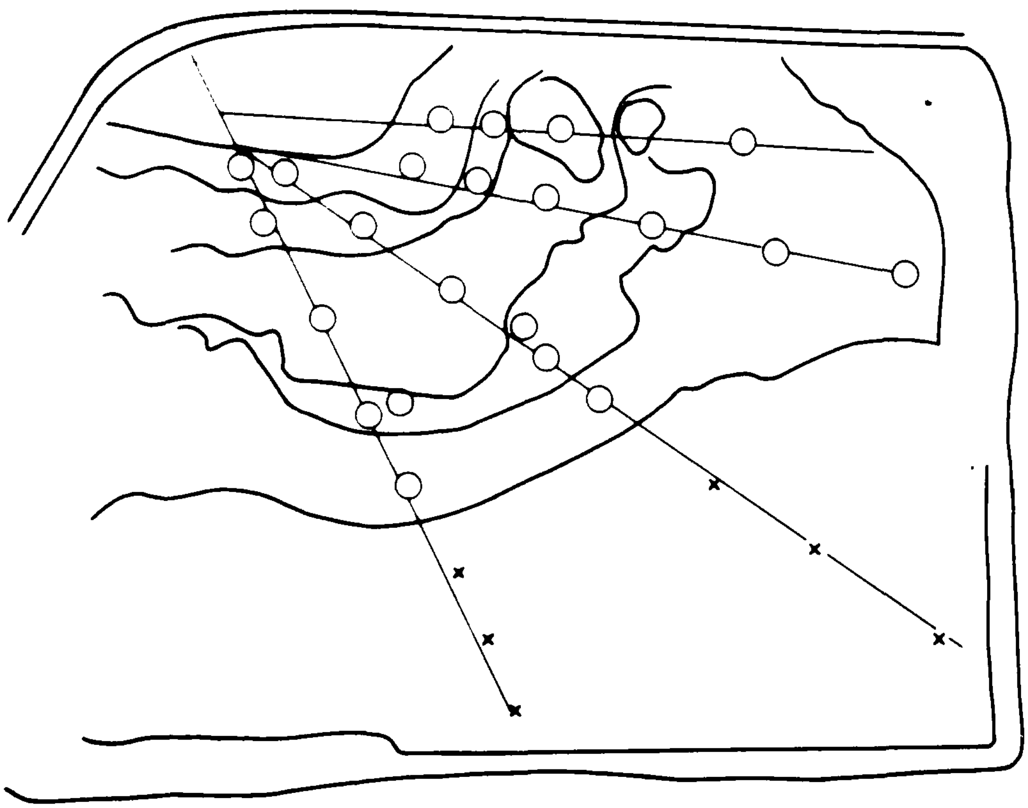

Figure 4

2. Items sampled

Surface plants (for analysis)
Root/rhizome sample for specific species (for analysis)

Soil fractions, plant and animal bioassay

Invertebrates
Plant survey (for cover/basal area and abundance)
Thru - fall and leaf catchment

3. Time phasing

a) Plants (for analysis phyto/root mass)

Early summer

Poa spp. leaves, roots (no flowers)

Mid-summer

Typha latifolia	Roots, rhizomes, seeds
Leersia oryzoides	Roots, leaves
Lythrum salicaria	Roots, lower leaves
Phalaris arundinacea	Roots, leaves

Late summer

Impatiens capensis	Roots, leaves
Solidago altissima	Rhizomes, seeds, leaves
Solidago gigantea	Rhizomes, seeds, leaves
Populus deltoides	Leaves, seeds
Cornus stolonifera	Finer roots, leaves
Salix interior	Finer roots, leaves

b) Soil fractions - early summer

Depth will depend on nature of vegetation zone-

c) Plant survey

Trees - early summer

d) Thru - fall, leaf catchment

4. Major zones

   Upper cottonwood

   Cornus/cottonwood

   Lower cottonwood

   Willow

   Phragmites

   Rice cut grass

   Typha

   Aquatic

SOIL INVERTEBRATES - TASK GROUP

I. PREDICTIVE TEST - EARTHWORM TESTING METHODS

Both toxicity and bio-accumulation need to be assessed in this procedure. The test needs further improvement and standardization. The dredged material must be brought to a condition in which the worms can survive and this can be done by the following methods:

i) Dilution with uncontaminated material

ii) Aging dredged materials naturally (until earthworms find the dredged materials acceptable and survive within them. The bioassays should then be carried out).

iii) Leaching and irradiating thin layers of dredged material held in trays with U.V. light[1]. This should be carried out indoors and under controlled environmental conditions. Methods should be aimed at accelerating natural weathering processes and not expose sediments to treatments they would not encounter under natural conditions.

The group greatly favored method (iii) as a standard method for the pre-treatment of all dredged materials but emphasize that experimental tests need to be run with a range of dredged materials. These would be exposed to the conditions in (iii) and periodically tested until they all reach a condition when the earthworms burrow into the material and remain within it. At this point a full bioassay as previously developed should be run to assess toxicity and principally bioavailability.

The value of the bioassay is to rank dredged materials in order of potential toxicity and bioavailability. Materials used in a full laboratory experiment should include dredged materials from sites that could be used in a field verification experiment.

II. VALIDATION AND FIELD VERIFICATION OF EARTHWORM TEST ON NEW SITES

Ideally, it would be preferable to set up a new field experiment on a single site which would test the ecological effects of field applications of dredged material. These material should be a subset of those dredged materials used in Section I (iii). The validation procedure would involve several steps including:

a) periodic sampling of dredged material for earthworm bioassay in the laboratory to compare bioavailability of contaminants after field aging of dredged material. These data can be compared to laboratory bio-accumulation data obtained in Section I (iii).

b) periodic sampling and analysis of earthworms that colonize the site naturally for bio-accumulation of contamination to assess the potential of different species.

c) relation of bio-accumulation of contaminants by earthworm to bio-accumulation by other key soil invertebrates colonizing the site naturally. These key individual species should be selected on the basis of their abundance and potential for bio-accumulation of contaminants.

If the ideal situation described above is not feasible (i.e. all sediments applied to a single site) then an equal number of individual sites where dredged material is scheduled to be applied should be selected. Again, these site should include those materials evaluated in Section I (iii).

The same steps - a, b, c should be followed regardless of the overall design.

Those invertebrates that are selected as key indicator species should be those used as food for predators in food chain studies.

III. WORK ON TIMES BEACH AND OTHER EXISTING SITES

a) Times Beach

It was decided that the main aim of future work should be aimed at identifying those plants and animals that have accumulated the largest (or most ecologically significant) concentration of contaminants. Samples should be carried out in spring or fall. Identification of such animals would include trapping or sampling invertebrate or vertebrate and analyzing the levels of contaminants in their tissues. This would yield important results in identifying key indicator species of animals.

Previous work done on the site has shown that variability in levels of contaminants in earthworms (from the bioassays) has not been great, so future sampling could be confined to bulk samples with only adequate replication.

Since most animals are mobile it would not seem necessary to do futher detailed analysis in terms of spatial distribution.

We do not recommend work on another reference site because this information in our opinion would not yield a great deal of useful information for this evaluation especially in view of the amount of work required.

Because we have no initial reference point for the toxicity or potential for bio-accumulation of the dredged material originally applied to Times Beach we suggest that material obtained from deep cores (unconsolidated and reduced material at depths of > 1 m) be used for laboratory bioassays. This could yield data which could link laboratory toxicity to earthworms to recent bioassays and the present status of Times Beach.

b) Other sites

Similar operations should be carried out on a selection of other existing sites of different ages. Attention to sites that have not become as ecologically desirable as Times Beach could yield useful data.

IV. FUTURE DEVELOPMENT AND MANAGEMENT OF SITES

We recognize that when serious contamination has been indicated by the previous evaluations then sites can be managed in various ways which include:

a) Limited acces by public
b) Physical alterations and modifications, such as cultivation, vegetation control, drainage etc.
c) Change in image such as filling and capping.

* The work described in these sections is envisaged as being carried out within the next year/6 months.

CONTAMINANT MOBILITY WORKSHOP - REPORT OF CHEMICAL ANALYSES GROUP

1. Sampling and analyses of aquatic sediments not previously done needs to be done. Date from Corps drilling investigations indicates top 2-5 feet is uniform organically enriched silts and clays. Therefore five random samples throughout aquatic area should be sufficient.

2. Since wetland and upland have previously been sampled, two additional samples from upland and 3 from wetland should be sufficient. Organic (Humus) layers in woodland and wetland should be sampled and analyzed (same sites as sediments). Dr. Black (Roswell Park Memorial Institute) will need 3 samples of sediment analyzed by GCMS.

3. Parameters

   A. Soils - Heavy Metals - Zn, Cd, As, Pb, Hg, Cr
   Organics - PCBs, PAHs, chlorinated benzenes, aromatic amines, oil and grease (or organic carbon particle size), nutrients; complete GCMS scan for 2-3 samples

   B. Plants - Metals as above - since organics have not been found previously, or found at very low levels, further organic analysis does not appear necessary

   C. Animals and Fish - Metals and organics as in A above
   Note - Lipid analyses on all animal and fish samples strongly recommended at summary meeting

4. The Buffalo District is especially interested in analyses of higher food chain organisms including mammals, fish, birds.

5. Quality Assurance - Reports should contain quality assurance data including spikes, replicates, standards.

6. Sample Storage - Store at -20°C

7. Data Format - Percent Ash and percent moisture of samples should be given to enable conversions.

8. Data Management - John Adams of Buffalo District, COE will develop computer system for treatment, storage, and retrieval of Times Beach chemical data (plants, animals, fish, sediments).

REPORT - AQUATIC AND WETLAND TASK GROUP

Objective: Develop a research strategy to assess ecological impacts of contaminated dredged material at the Times Beach containment site: That effect the Wetland and Aquatic habitats.

A comprehensive ecological survey should be conducted to determine community structures and trophic relationships. Key species should be identified to ensure appropriate selection for biomonitoring. Contaminant concentrations in sediments, detritus and major components of the food chain should be measured. Food sources and contaminant transfer should be determined. Contaminants to be analyzed must included PCBs, HCB, Hg, Cd and other compounds as determined by the chemistry task group.

Organisms from the site should be collected for analysis and transplant experiments should be conducted with "pristine" organisms to determine the potential for bioaccumulation and transfer. Concurrent laboratory studies should be conducted to gain further understanding of processes pertinent to contaminant uptake, transformation and transfer between trophic levels. The following species are recommended for transplant studies:

- *Lampsilis sp.* (suspension feeder)
- Tubificids (deposit feeders)
- *Lymnaea sp.* (grazer)
- selected fish species (omnivores/carnivores)

Because of the difficulty in isolating anthropogenic sources from naturally occurring processes field and laboratory studies should address the redox conditions which exist in the wetland and aquatic habitats of the disposal site. In addition changes in pH caused by plant productivity must be considered.

Because the most significant impact could be long-term and sublethal the following physiological, developmental, mutagenic and population responses should be considered:

physiological - bioenergetics
- immune response

developmental - life cycle testing (i.e. *Hexagenia*)
- larval abnormalities (i.e. tadpoole) lymnaea

mutagenic - Ames testing
- chromosome abnormalities (i.e. mud minnow)
- gross morphology/histopathology

population/ community - size frequency distribution
- productivity/biomass

Due to the lack of adequate control sites, we suggest a literature review of key species and contaminants of concern be conducted to provide baseline data with which to compare measured values from field and laboratory studies.

We recognize the limitations of time and resources and therefore recommend the following prioritization of the aforementioned tasks:

1) Faunal survey
2) Bioaccumulation (Transplant Experiments)
3) Food chain dynamics
4) Sublethal effects

REPORT-MANAGEMENT TASK GROUP

Potential Use: The future use of Times Beach will depend on the needs of the City of Buffalo. The group identified three primary potential uses for the site. These are commercial/industrial/residential (CIR) use, use as a recreational park or use as wildlife habitat.

The CIR use could be desirable since the site consists of more than 7500 ft of frontage to navigable channel. In addition it could lead to improve economic development. However alternative areas for this kind of use are available and Times Beach needs substantial modifications for development.

A recreational park provides intensive public use like picnicking, boating, jogging, bicycling. These uses normally are accompanied by undesirable activities like littering, noise, vandalism. Modifications of the site (placement of fill, construction activities) will be necessary. Alternative sites are available.

Currently the Times Beach area is primarily used as wildlife habitat. It seems to be uniqye to this area of Buffalo. Within the uses of this site are resting/nesting of migratory waterfowl and other organisms. The ongoing succession taking place at this area can serve for scientific studies and with only minor modifications could be developed as a nature study-observation area. One majore detriment to this usage might be the contaminants within the site. The intensity of the last mentioned use will be the least intensive usage by the people of Buffalo of the three. Taking all these factors into consideration the group recommends the site to be maintained as a wildlife habitat at the present state of knowledge on contamination.

Monitoring/criteria

With the assumption that the site will be maintained as a wildlife habitat area the following are the monitoring/criteria considerations. An intensive multiple-year study should be undertaken to provide appropriate background data. Afterwards there is needs to conduct additional monitoring to detect changes on the long term in the ecology of the area.

To improve sampling and monitoring a grid system should be developed for the site. This will help to increase precision and coordinate the work of different groups. Chemical, physical and biological properties of the site should be evaluated extensively (see reports of the other task groups).

Monitoring of the water exchange through the dike (including flow rate, direction, variable permeability and contaminant exchange capacity of the dike) would provide information of the impact of contaminants in the site to the surrounding area.

Monitoring the airborne pollutants is necessary to determine the relative influence of these to the overall contamination of the area.

Determine species usage and food chains involved within the Times Beach ecosystem. This information is vital for a contaminant budget for the site.

Data on gas formation in the substrate could be determined because primary or secondary adverse effects could result (mortality of plants, cycling of nutrients in the open water section etc.).

Criteria should be developed to allow decisions as to when active management should be conducted (e.g. capping of the total or part of the site).

Succession and population dynamics of resident species should be monitored. Physiological impact on species as well as communities should be evaluated as a sensitive indicator of impact due to contamination.

Long term management

Should active management be required to enhance or eliminate certain species, these must be defined for the differing habitats. To keep the site stable and productive, management techniques such as burning may be necessary.

To avoid adverse effects on the biota, the access to the site should be limited, and research work must be coordinated to avoid unnecessary disruption.

If established contaminant criteria are exceeded appropriate, remedial options must be implemented.

SUMMARY (C.R. Lee)

1. Three transects across vegetative zones (similar to Figure 1)

2. Eight vegetative zones (Figure 4)

3. 24 sampling stations (upland-wetland)
   1 aquatic station
   25 sampling stations

4. Vegetative sampling
   - 3 samples per station for upland and wetland areas
   - 9 samples in aquatic zone per plant species

5. Soil samples cores
   - 3 cores per station for upland and wetland areas
   - 9 cores in aquatic zone (3 along each transect that passes through aquatic zone); 3 additional cores are separated into litter, organic layer, mid layer (A2), anaerobic bottom layer (Hunter's overhead)

   May decide 9 samples from

   x4
   36 samples

   Depth

woodland	3 x	27	+ 9 litters =	36
upland	3	27	+ 9 litters =	36
wetland	2	18	+ 9 litters =	27
aquatic	2	18	+ 9 litters =	27
		90	samples total	126

6. Soil invertebrates:
   - 3 determinations per station or
   - 6 determinations (samples) per zone (woodland, upland, wetland, aquatic)

7. Earthworms:
   - 6 samples (composites) per zone (woodland, upland, wetland, aquatic)
   - Hunter's overheads

8. Plant and earthworm bioassays
   - Plant bioassays relate to 8 zones; earthworm bioassays relate to soil samples cores.

Report: R 87/15 WES-TNO Contaminant Mobility Research
Final Technical Report

Appendices	1: R 87/023	Proceedings of the 1984 Workshop, held at Buffalo, USA
	2: R 86/199	Musselwatching in the Buffalo River, Times Beach and Lake Erie
	3: R 86/220	Preliminary inventory of planktonic and benthic organisms at Times Beach
	4: P 85/50	Animal bioassays of black rock harbor sediments - Field verification at an experimental wetland-creation disposal site
	5: P 87/007	Morton Arboretum Bioassays.

ANNEXE A

Participants that were reimbursed for travel to and from Buffalo (N.Y.) - Europe and for per diem.

J.W.J. Gielen
C.A. Edwards
W.H.O. Ernst
B.A. Hunter
M.A. Ireland
R.H.D. Lambeck
W.J. Langston
W.C. Ma
J.M. Marquenie
F. Prosi

Participant who was reimbursed for travel only.

L. Tent

Invited participants that were unable to attend the work shop.

M.S. Johnson
H. Nijssen